MINNESOTANS IN NATURE:
TRENDS AND PROSPECTS

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COMPONENTS OF THE NATURAL SYSTEM

Air, water, soil, forest, and mineral resources are produced and renewed by natural processes. The stock of those resources in Minnesota at any one time is determined by the rate of flow through the various "systems" that are constantly in operation--the general atmospheric circulation, the hydrologic cycle, the process of plant growth and succession, the geologic cycle from erosion to deposition to lithification to uplift and back to erosion.

To review and appreciate the geographic structure of these systems, and our location within that structure, it is essential to have at hand the maps in Chapters 1-4, of the Atlas of Minnesota Resources and Settlement, or the "Natural System" section of the Selected Maps of Minnesota's Environment prepared for this conference(1).

These natural systems are gigantic in scale. Measured in terms of the energy they consume or the mass of material they move, they make the most spectacular of human efforts appear miniscule. But their behavior can be modified, especially in local or regional details, by human activities. Human modification of the natural resource systems is inevitable because the systems serve to concentrate certain materials useful to human society in particular locations. Those places become the locus for resource-based activities and settlements. The resulting interaction between human and natural systems modifies both and gives every inhabited region on earth its distinctive character.

Air

The flow of air across Minnesota comes typically from one of three different sources, and brings with it the properties of each source region--the low temperature and pollution-free environment of the Arctic, the heat and dust of the western interior, or the warmth and moisture of the Gulf. These unlike airstreams converge into the passing low pressure centers that move across the Upper Midwest, most frequently from western Canada toward the Great Lakes. Thus the frequency of rain and snow increases toward the northeast, where lows are most frequent. The intensity of rainfall increases toward the southeast, where fronts are most likely to encounter a stream of wet air from the Gulf. And drought risk increases toward the west, where the wind is most likely to blow from the continental interior.

Although these gradients are vitally important, there are no clearly defined "natural regions" in the state's atmosphere; for the whole weather process in the middle latitudes is devoted to constant swirling

and mixing of the air resource through the mechanism of passing cyclonic storms, or lows. Nevertheless, there are local variations resulting from the effects of terrain or settlement--locally higher rain and snowfall on the high ground of southwestern Minnesota and the Arrowhead, or local concentrations of fog, haze, and smog in the Twin Cities area.

Water

The basic water resource is the runoff--that is, the amount of rainwater and snow-melt that remains after the air has taken its share through evapotranspiration (direct evaporation and transpiration from the plant cover). Some of the remaining water soaks in, passes through the ground water reservoir, and emerges from springs along the stream valleys; the rest runs directly off the surface of the land to the streams. Ultimately both the direct and indirect runoff are measured in the flow of the streams; and that flow represents the total water budget with which we have to work.

The average annual runoff--the basic water resource--is eight to ten inches or more in northeast and southeast Minnesota and drops to less than one inch along the boundary with the Dakotas. Thus water runoff equals about one-third of the annual average rainfall in the cooler and cloudier northeastern part of the state, about one-fourth of the annual rainfall in the somewhat warmer southeast, and less than one-tenth of the annual rainfall in the sunnier and drier west. Water productivity of the natural hydrologic system is greatest where temperatures are lowest and precipitation highest.

Meanwhile, there are very important local variations in runoff, superimposed on the climatic gradient. The indirect runoff depends on the soil and bedrock material. Where the soil is sandy--for example north of the Twin Cities and east of St. Cloud--water soaks in easily and moves readily through the ground. On the clay soils of large parts of western and southern Minnesota vertical and horizontal percolation are slow, and the capacity of the ground water reservoir is limited. There are similar variations in bedrock, with the greatest ground water storage capacity generally in the southeastern quadrant of the state.

Direct runoff varies with differences in the drainage pattern. Over most of the state water runs slowly off the land. It is detained in the countless lakes and swamps, ponds and lakes, which are legacies from the random pattern of glacial deposition or erosion. Hence a very large part of Minnesota's natural runoff is normally in storage on its way to the ocean. The greatest natural storage capacity is in the ice-scoured country of the Arrowhead and Border Lakes region and the glacial moraines that dominate the belt from the Grand Rapids and Brainerd areas westward and then southward through the districts of Bemidji, Park Rapids, Detroit Lakes, Alexandria, Willmar, the Twin Cities, and Albert Lea. Natural surface runoff storage capacity is much less, though still

significant, on the gently-rolling or flat glacial plains in the Red River Valley, west-central, and south-central Minnesota. Capacity has been reduced in those regions, also, by agricultural drainage of the shallow depressions with their potentially highly productive flat-bottomed basins. Surface runoff is most direct and rapid in the south-eastern corner of the state, where the glaciers had little or no effect and there is a completely developed system of streams with no natural lakes or wetlands except those along the floodplain of the Mississippi.

Vegetation

The type and productivity of natural vegetation depends upon the climatic heat and moisture and the fertility of the soil. In response to the climatic gradient and the length of time since glaciation, natural processes produced the spectacular transition from the pine and northern hardwoods of the Arrowhead, through the "big woods" and "park region" to the open prairies of the west and south.

Against that broad background pattern, nature embroidered countless details in response to local differences in soil materials, slope, and exposure--the prairie openings on the droughty, sandy soils of central Minnesota; the groves on stream banks and lake shores of the prairie region; or the goat prairies on dry south-facing slopes in the stream-dissected region.

In turn, the natural vegetation greatly influenced the soil. The litter and deep shade of the pineries helped to make the soils of the northeastern one-third of the state inherently less fertile, more acid. The deep, dense roots of grasses and forbs helped to make the heavy glacial surface material of the west and south more friable and rich in nitrogen. As a result, the first white settlers found prairie soils with perhaps seven times the natural fertility of those in the north-east; and that initial advantage has been recycled through continued high output and capital investment so that today the difference in productivity is greater than ever.

Minerals

Although they are produced by the geologic cycle, and are therefore essentially static and "non-renewable" on the time scale of human history, the state's mineral resources are also the result of the operation of a natural system.

The major concentrations of ore minerals are famous--the largest reserves of iron ore in North America and perhaps the largest reserves of low-grade copper-nickel ores in the United States. The quantity and quality of these ores are well-known, and the iron ranges appear in considerable detail on maps published throughout the world.

In contrast, the other major mineral output of the state--sand and gravel--comes from countless pits for which no comprehensive map

exists--even for the most important producing areas of the state. Much smaller--though significant--mineral industries are the granite, glass-sand, limestone and fire-clay quarries.

The regional concentration of the state's mineral wealth is also the result of natural process. Sand and gravel deposits were dumped where they are by the random events of glaciation. The clay, limestone, and glass sand are the result of events that occurred on the floor of one corner of the world's ocean when it covered this area a quater to a half billion years ago. And the metallic ores are where they are because of the random location of upheavals in the earth's crust and thermal turbulence in its deep interior even earlier in the history of the planet.

The timing of those events is noteworthy if only for the perspective it provides both on the current human use of mineral resources and on the time scale within which one- to ten-million year-old mankind discusses its "survival".

Natural System, Natural Resources, and Land Use

Since the operation of the natural system has resulted in the concentration of particular chemical elements and compounds of special value to human society in particular locations, those natural systems are interwoven with every manner of socio-economic-technologic system we are able to conceptualize. Resources, and therefore the operation of the natural systems, are defined and evaluated by the culture and technology at a given time and place.

Human use of resources and intervention in the natural system has resulted in very large scale modification of the environment again and again during man's residence on earth(2). Noteworthy American examples are the burning of the great grasslands and savannas, the cutting of tens of millions of acres of forest for charcoal and stovewood, or the clearing and cultivation of hundreds of millions of acres of farmland. Examples in Europe and Monsoon Asia go back many more centuries. While it is true that the energy and knowledge with which human societies can modify the environment has grown many fold in the past two centuries, and especially in the past half-century, it is also true that the energy and knowledge available for management of the modification have grown equally, although the use of those assets has lagged.

Any modification of the natural environment is the result of "land use". Hence environmental management is land use management; environmental control is land use control; and environmental planning is land use planning. To be sure, the converse is only partly true. The impact of land use on natural systems (or natural environment or natural resources) varies depending upon the type of use and the size of the parcel in question. And it is worth noting that both terms--natural systems and land use--either focus on or ramify into virtually every aspect of the works of man and nature.

The map in Figure 1, and the accompanying tables, indicate the general statewide pattern of land use in Minnesota and the accompanying pattern of ownership and assessed valuation.

MAJOR ISSUES

Because of their potential impact on the natural resource system--or some part of it--certain types of land and resource use have become particularly controversial. Questions have arisen over whether certain land uses should exist at all; and more sophisticated questions are emerging concerning where they should be located. These questions and issues will continue to dominate the land use stage--in some form--in the future.

Major types of development or preservation, which have been the focus of discussion, include the following.

- Large Industrial Installations. These include--at present--power plants, coal docks, mines, and smelters. In the future other kinds of large-scale material conversion or storage installations will surely come on the scene. The problem arises from the fact that the economic scale of this type of operation has become so large that it can no longer be contained in the traditional urban industrial zone and its surrounding traditional city; and there is no tradition within which to approach the question of its suburban or exurban location. Floodplain development issues to a large extent are included under this heading.

- Agricultural Land Use. As a practical matter, this should include not only crop land in the traditional sense but also grazing and commercial forest land, especially the latter, for the commercial forest is increasingly treated as a managed crop. The principal public questions concern the preservation of especially suitable land for agricultural purposes; the effect of fertilizers, pesticides, and large-scale livestock operations on the quality of surface and ground-water runoff; and, currently somewhat out of the general public's focus, protection of crop lands from soil erosion and depletion.

- Expansion of Urban Settlement. Emphasis here is on the location and development pattern of residential expansion and accompanying service facilities. The principal issue is density. Although there is concern that high-rise residences be kept in their proper place and spacing, there is also concern that urban residential expansion become more compact and clustered than it has been during the post-World War II building boom and the subsequent decade, to facilitate economies in the provision of roads, utilities, and collection and delivery services. And there is concern about the amount of attention given to aesthetics and natural surroundings by large scale residential and commercial developers, and by those who reside along the shores of the state's many lakes. The issue of floodplain development appears here, also, but only in a minor degree.

- Solid Waste. The issue is where to put it, and why. The "where" issue arises because of the actual and perceived high nuisance

which large-scale storage of these materials poses for the adjacent neighborhood and the consequent relatively long distance haulers must go to escape the residential outliers of any large, waste-generating urban center. The "why" issue arises because of uncertainty, in a changing technology and society, about what can and ought to be done with the material--recycle all as a source of industrial raw material, burn as a fuel and recycle the residue, store in large concentration for future mining, store for natural decomposition?

- Open Space for Public Recreation or Preservation. The issues here continue to be how much do we really need? Where? Why? And how much can the public afford? Minnesota's record is good in comparison with the other states of the nation. But the questions continue to beg systematic answers.

COMING RESPONSES

Each of the major issues has been generating response over the years, and the pace has quickened significantly since Earth Day and the subsequent remarkable developments of recent history. Those responses are now beginning to form some outlines which are likely to become very clear in the coming years. Two principal lines of development seem likely--the introduction of missing elements which are fundamental to rationalizing the environmental control process, and the establishment of large-scale zoning with accompanying environmental performance requirements.

Rationalizing the Environmental Control Process

The first missing element is a land and water information system. The system will include information on resource quality and quantity, utilization, value, and ownership. The status of each of these variables will be monitored at regular places and times, and the results reported quickly in standardized form. The system will include not only an automated data bank and analytical capability but a library of conventional maps and statistical sources, readily accessible and reproduceable on microfiche or photocopy.

Minnesota is probably farther along the road toward such a system than any other state. But that is still not very far, and much remains to be done. Much of the data collection work is already being done in connection with tax, licensing, and permit activities; but statewide organization and standardization are lacking, and major gaps exist in the data. It seems certain that this need will be met fully in the next ten to fifteen years at most (3).

The second missing element is a state-wide land use plan. The plan will pertain to some specified unit or parcel--probably the forty-acre parcel in the official land survey; since that is the uniform basis for legal description of virtually all of the rural land in the state, and the framework within which most urban platting has taken place. The plan will indicate for every parcel the relative suitability and priority of every parcel for each of several broad classes of development or preservation. The suitability and priority will depend upon specific qualities of site and location using criteria which are applicable state-wide and take into account the widely different characteristics of both the resource base and the historical development.

The plan will not be used as a rigid blueprint. Rather, it will provide the basis for regional commissions and state agencies to review and react to all local or special agency plans and proposals--public and private--within the limits of powers delegated to them by the legislature. There probably will be little change in the present distribution of delegated powers unless experience and real pressures justify it. But it will become apparent that policies are mere rhetoric unless they apply to the real places within the state and there

is a clear understanding of where and how they apply. It must be possible to show on a map the potential patterns of land allocation and resource use which state policies actually produce, for all to evaluate and review and perhaps to change in the light of experience.

In short, this kind of state land use plan will be subject to modification with changes in the general public understanding of the situation. But it will be recognized as the only specific evidence of coherent public concern about the environment.

Again, Minnesota is probably as far along toward the ability to develop such a plan as any other state, farther than most. Yet much remains to be done, and it seems likely that pilot maps can be developed within two to four years, and refinements and revisions will continue as long as interaction between agencies, local governments, and the public continues, and as long as the data base, analytical techniques, and general understanding of the state's land use keep getting better.

Large-Scale Zoning

Large, regional "zones" already exist de facto in many parts of the state. They have evolved in the market place as a result of the localization of particular resources, accessibility, or ideas[4]. Issues have arisen most commonly where those zones have been ignored in particular land use decisions, or around the edges of those zones, where the situation is fuzzy, the zone has not been clearly identified or understood, and there are no performance criteria. Examples are residential developments that have strayed into prime crop land or large-scale mineral processing operations that strayed away from the de facto mineral industry zone on the Iron Ranges, into a prime coastal zone of scenic high-relief terrain.

One can speculate on the principles and perhaps some of the consequences which will emerge as large-scale state or regional zoning becomes a fact.

- Heavy Industry. Acceptable locations will be defined by considerations of accessibility to the navigable waterways, mineral deposits, metropolitan markets, and location in which local impact on either settlement or natural environment will be minimized (for example, virtually unused land of a type which is in abundant supply, with minimal scenic relief or recreational waters, or areas already characterized by viable, high-nuisance, heavy industries).

  Acceptable site conditions will be defined by local soil, slope, and drainage conditions and by the character of neighboring settlement. Floodplain development will generally be prohibited, while some large-scale water storage will be encouraged, especially for the Twin Cities and Iron Range.

  Performance requirements will specify in advance, for a given heavy industrial installation at that site and location,

maximum acceptable waste discharges, visual disturbance, and large material storage areas. Performance requirements will also recognize the feasibility of making wild life, water features, and natural land features integral to the layout of plant and grounds.

Performance criteria for a given site, location, and development class will be set so that, when met, they will be tantamount to submittal of an environmental impact statement. The fact that zoning performance standards and environmental impact assessment are opposite sides of the same coin will surely be recognized, and the present environmental assessment procedure will be streamlined and rationalized.

- Agriculture. Market forces will continue to produce the major outlines of patterns and changes. Most of these will be rational in terms of resource and accessibility considerations.

  Most of the arable land which has been set aside in federal acreage reduction programs will be returned to cultivation, at least intermittently.

  The largest, most productive enterprises will continue to concentrate on the best soils and the most nearly level land--the prairie till plains and the Red River Valley. Both marginal and labor-intensive types of farming will concentrate in the transition zone (Figure 1), especially in commuting range of the the principal urban employment centers, for part-time farming in combination with urban jobs or retirement will continue to grow, spurred by high food costs and declining buying power.

  Supplemental irrigation is likely to expand significantly on the sandy soils of central Minnesota, and on the rich land of south-central Minnesota in those places where there is ample ground water. Flood irrigation of cultivated "wild" rice is also likely to expand significantly in the bog lands of northern Minnesota.

  There may be some consideration, by the 1980s, of long-range plans to transfer supplementary irrigation water from the high-runoff region of the Mississippi headwaters to the region of high-quality soils, low runoff, and limited ground water in south-central Minnesota. Accompanying such discussion, there might also be preliminary consideration of where to store the water within the high-runoff region.

  There may also be some consideration, by the 1980s, of restricting the use of agricultural chemicals in certain recreational lake basins within the marginal farming areas, in order to preserve or help restore lake quality[5]. There may be an accompanying consideration of abandonment of concerns

for lake quality in most of the main agricultural region of the state and treatment of surface runoff collected from that region as an alternative to prohibition of the large-scale use of chemicals to sustain high yields. In general, the major agricultural region of the state--and that of the Midwest as a whole--may come to be recognized as a very large, distinct, well-defined, and basically important "garden" or "industrial farming zone"--whatever term one prefers(4).

By the mid-1990s the amount of presently available forest land may no longer be enough to meet the demand for logging if lake-shore and scenic relief areas in the forests are preserved. This could sharpen the conflict between logging and recreation or preservation in certain forest areas. However, more than enough land to resolve the issue is presently unused or pastured, within the main forest region of the state. It is likely that the importance of reforesting that land will be recognized. Thus the present de facto logging zone of the state is likely to be more formally recognized and defined, with an accompanying definition and exclusion of extensive recreation and preservation zones within the same forest region. The concept of "multiple use" is likely to be either relaxed or redefined to mean "zoning".

- Urban Residential Expansion. One hundred fifty to 300 square miles (100 to 200 thousand acres) of new residential land will be added state-wide by 1990(4). That is equal to 10 to 20 percent of the present urbanized area of the state.

  Perhaps ninety to 95 percent of the new dwelling units will be built by development firms; hence the people who occupy those units will be shopping for their housing as merchandise within a framework of locational decisions already made by the developers. Most urban housing location decisions have been made traditionally in this way.

  For this large part of the housing market there will be increasing pressure to locate at the edge of existing sewered neighborhoods, on vacant by-passed land in the older urban areas, or in planned unit developments where all utilities are installed at the time of housing construction.

  Reasons for these pressures include: increased zoning, monitoring, and enforcement of regulations by local governments; pollution controls; reduction of work-trip length to cut family expenses; need to concentrate mass transportation routes in corridors between major centers in order to achieve economies; pricing of line services, such as roads and utilities, increasingly on the basis of their real cost as it varies between high-density and low-density settlements; decreasing real buying power of family income, forcing increased use of

older, existing buildings; high cost of money and large amount of front capital needed to open any new settlement which meets all environmental requirements.

Limitations on the trend toward more compact settlement, focused on existing concentrations, may also appear in the Twin Cities metropolis, especially. Major limitation may well be the ability of organizations committed to preservation of established communities to open those communities to cultures and building technologies which are alien to the community--cultures and technologies which are now generally confined to the ghettos, the chaotic transition zones in the central cities, or the equally chaotic outer metropolitan fringe. There will be clarification of the significance of and the difference between community preservation and segregation.

The remainder--perhaps five to ten percent--of the new dwelling units will be built on acreages in rural areas. Most parcels will range in size from 5 to 20 acres, in accord with local regulations and land costs. By the 1990s these exurban acreages could account for most of the privately-held land within one-hour driving time of the central Twin Cities. Reasons for this development: continued existence of individualistic frontiersmen in the population--families with the necessary combination of ingenuity, inclination, income, and mobility; continued existence of farmers or other landholders with land of low agricultural suitability not in demand by public agencies or non-residential users. Those two groups will continue to get together in the market-place.

Limitations on this kind of development will be imposed by: special performance standards in ground-water recharge zones; lakeshore development standards controlling densities and setbacks to preserve lake quality and protect residents from fluctuating lake levels.

- Public Open Space for Recreational Use or Preservation. If post-World War II trends continue, the state and local governments in Minnesota will acquire another 300,000 acres of park land by the end of this century. The acreage of state and local park land per capita rose from 0.6 in 1950 to 0.9 in 1970--about twice as fast as the rate for the nation as a whole[6]. However, use of the parks increased very rapidly, and acquisition did not keep up with increased use[7]. If increased use were considered, new acquisition of park land would go to one million acres or more by the end of the century. Much of this land could be acquired or transferred from other state agencies. For example, the 1970 Minnesota Lakeshore Development Study showed that the Highway Department owns more sand beach on recreational-quality lakes than the State Parks Division does[5].

There is likely to be a marked re-orientation of open-space policies.

(1) More systematic consideration of what is acquired. Rather than a bit of sand beach here and an old building there, increasing emphasis on large tracts (1000 acres or more) that have marked the face of the state--mainly glaciation; major historic waves of American Indian, European, and Afro-American migration; the technologic evolution of farming, forestry, mining, and transportation; and transformation of towns and cities(7).

(2) Earlier acquisition of land in the path of general urban development.

(3) Recognition that scenic views from public highways may well be our single most important critical areas--viewed and potentially enjoyed by more people than any others; sites of large public investments to make them accessible; fragile in the sense that they can be greatly reduced in value by littering, careless driving, or unlimited access and roadside development. Highway improvement is likely to be much more closely integrated with open space acquisition and development programs.

(4) More use of no-cut zoning in the forested areas to preserve not only public investment in scenic drives but also the view from public waters in which there is substantial public investment in maintenance of quality.

(5) More emphasis on metropolitan accessibility in public land acquisition and development.

IMPACT OF POLICIES AND ACTIONS

These future policies and actions will not drastically alter the present patterns or over-all quality of the state's natural resources of water, air, and land. But they will make profound and desirable changes in many localities. The reason is the over-all abundance of these resources together with the comparatively localized nature of the problems.

The Water Resources Coordinating Committee has stated emphatically that, "Properly developed, the state has adequate water supplies, even during extended dry periods, to meet all foreseeable domestic, municipal, industrial, and irrigation demands."(8) All water withdrawals in the state in 1965 accounted for about 28 percent of the total runoff, and are projected to account for about 51 percent of the total by the year 2020. Actual water consumption accounted for 2.5 percent of the average annual runoff in 1965 and is projected at 4.5 percent by the year 2020. But most of the runoff is available in concentrations in three or four major rivers and Lake Superior; and most of the present and future need is concentrated in a few urban, industrial, and agricultural locations.

The land resource is also abundant in absolute terms. There is plenty of land, over-all(3). The area of the state that is virtually unused for any direct production or recreational purposes must be of the order of ten million acres. Maximum anticipated development of both taconite and copper-nickel mining would pre-empt less than two percent of the forested land in the northeastern forest region of the state. There is ample land in reserve to increase the commercial forest region to meet anticipated future needs without encroaching on scenic relief and lakeshore in the forest region. About five thousand square miles of open land (fewer than five dwellings per forty acre parcel and no platted streets or urban-type lots) surround the Twin Cities within one hour's driving time of the core areas. There are largely unused areas of former glacial lake bottom which could be restored to their natural, early post-glacial state by damming, diking, and flooding, should the need arise to increase water storage capacity in the high-runoff region of the state, in order to meet increased demands in the major urban and agricultural areas. The critical need is the one spelled out at the beginning of the Rockefeller Brothers Fund Task Force report, The Use of the Land: to see that ". . . conservation and development occur in the right places."

Data on air use are not so readily available. But the total flow of air across this state, just in the lower, turbulent layer of the atmosphere in which we withdraw and discharge most of the air we use, is of the order of tens of billions of cubic miles per year. And most of that comes directly from the most nearly uninhabited, antiseptic, pollution-free environments in the northern hemisphere. As it is the case with water and land, so it must be the case with air: properly developed, there is plenty to meet all foreseeable demands.

Nature is an abundant supplier, but the management task is left to the users, scattered in their settlements across the face of the land.

And what are the costs of increasing management? The "major issues" and "coming responses" outlined above indicate that expenditures, by major public and private institutions of Minnesota over the rest of this century, affecting the natural systems, will be for solid waste disposition, water resources development, public open space, air clean-up, and transportation development.

Solid waste expenditures will cover new plant, equipment, and land costs, still largely unknown. Water development expenditures will provide new sources, transfer, purification, distribution, and waste treatment. The Water Resources Coordinating Committee projected a total outlay of 600 million dollars (1968 prices) for those purposes from 1968 to the year 2020 in Minnesota[8]. One might want to double that figure, arbitrarily, to 1.2 billion dollars to take into account possible inflation of water development relative to other prices. Recent federal authorization for air and solid waste pollution control have been running about fifteen percent of the amount authorized for water pollution control[6]. Taking that ratio, one could allocate roughly another 200 million dollars for development of air and solid waste control technology. Public open space acquisition and improvement could conceivably involve another million acres of land, much of it in the zone of metropolitan influence on land values; perhaps another one billion dollars. Extraordinary transportation expenditures will probably emphasize the expansion of mass transit, especially to provide fuel economies in the high-volume corridors. The Metropolitan Transit Commission has been authorized to spend nearly 110 million dollars over the next three years for capital improvements[9]. Suppose that kind of program went on indefinitely and the rate of expenditure were doubled.

The result would be an additional 3.6 billion dollar outlay over the next half-century. The total is 6.0 billion dollars to the year 2020. Add 30 percent for administrative and other overhead, and the total rises to 7.8 billion in the state of Minnesota over a half century.

Meanwhile, a very conservative estimate of future personal income per capita, combined with an assumption of zero population growth after 1990, yields an estimate of 350 billion dollars in personal income in Minnesota during the same period, expressed in 1968 dollars[8]. Thus a somewhat immodest estimate of environmental cleanup costs turns out to be about 2.2 percent of a very conservative estimate of personal income. . . a little more than two cents on the dollar. And a substantial part of the investment will be returned in user charges.

In 1972 all state and local revenues in Minnesota equalled approximately nineteen percent of all personal income in the state. Meanwhile, federal government receipts from taxes were equal to twenty-four percent of total national corporate and personal income. Thus, even if the bulk of these new investments appeared initially in the form of tax increases, they would make a comparatively small increment to the present bill, or to the increasing socialization of the economy.

In short, it appears that there is not only ample land, water, and air but also ample money. As it is in the case of the natural resources, so it appears to be in the case of the economy. Essential future changes will have very important local impacts but, at the same time, will be relatively small perturbations on the larger system. The critical questions will be whether sufficient understanding and agreement about the needs can be developed to produce the necessary commitment by the state-wide community.

REFERENCES:

(1) John R. Borchert and Donald P. Yaeger, Atlas of Minnesota Resources and Settlement, St. Paul: Minnesota State Planning Agency, 1968-1969.

(2) William L. Thomas (ed.), Man's Role in Changing the Face of the Earth, Chicago: University of Chicago Press, 1956; Thomas R. Detwyler (ed.), Man's Impact on Environment, New York: McGraw-Hill Book Company, 1971; Ian Manners and Marvin Mikesell (eds.), Perspectives on Environment, Washington: Association of American Geographers, 1974.

(3) See numerous reports of the Minnesota Land Management Information System (MLMIS), Minneapolis: University of Minnesota Center for Urban and Regional Affairs and Minnesota State Planning Agency.

(4) John R. Borchert and Donald D. Carroll, Minnesota Land Use and Settlement 1985, Minneapolis: University of Minnesota Center for Urban and Regional Affairs and Minnesota State Planning Agency, 1970.

(5) John R. Borchert, George W. Orning, Les Maki, and Joseph Stinchfield, Minnesota's Lakeshore (Part I: Resources, Development, Policy Needs), Minneapolis: University of Minnesota Center for Urban and Regional Affairs for the Minnesota Natural Resources Commission, 1970.

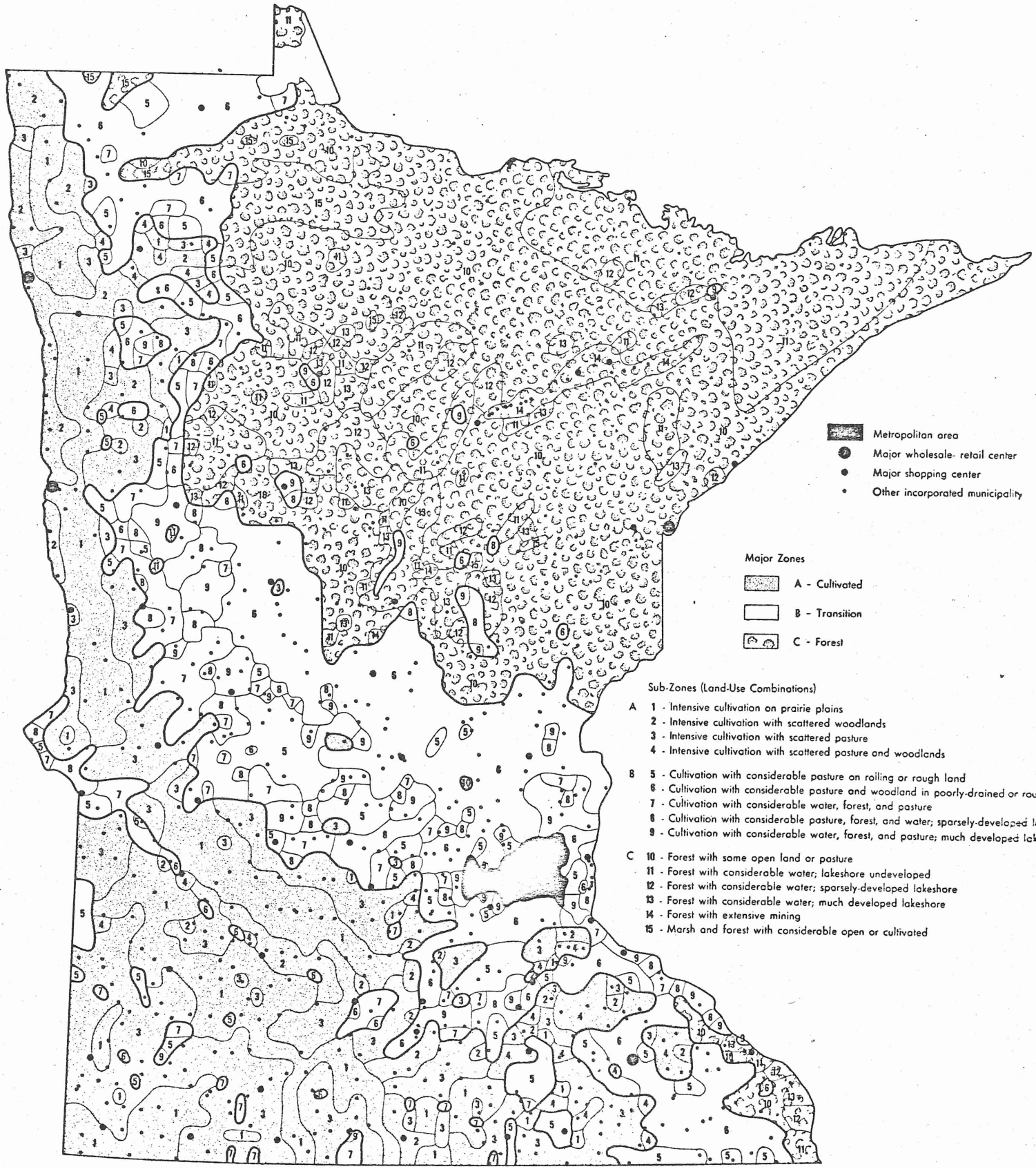
(6) Statistical Abstract of the United States, Washington: U.S. Bureau of the Census, annual.

(7) John R. Borchert and F. Robert Edman, Report Number One, St. Paul: Minnesota Outdoor Recreation Resources Commission, 1967 (MOORC Staff Report No. 1).

(8) Minnesota Water and Related Land Resources: First Assessment, St. Paul: Minnesota State Planning Agency Water Resources Coordinating Committee, 1970.

(9) "Significant New Metro Affairs Legislation Adopted in 1973-74", Citizens League News (23:7), April 19, 1974.

Figure 1. Generalized Land Use in Minnesota, 1969. (Data are for minor civil divisions (rural townships, incorporated municipalities).



--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

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TABLE 1 Land Use Combinations Used To Characterize Different Minor Civil Divisions (Rural Towns and Incorporated Municipalities) in Minnesota

Land Use Combination	Land Use Dominant on Greatest Acreage	Land Uses Present in High Percentage Compared with State Total	Other Land Uses Present in Moderate Percentages Compared with State Totals	Other Uses Present on Small But Significant Acreage	Landscape Description
Cultivated Zone					
1	Cultivation	Cultivation		Open, Extractive	Intensive cultivation on prairie plains
2	Cultivation	Cultivation		Forest, Open, Extractive	Intensive cultivation with scattered woodlands
3	Cultivation	Cultivation	Open	Water, Marsh, Extractive, Open	Intensive cultivation with scattered pasture
4	Cultivation	Cultivation	Open	Forest, Marsh, Extractive	Intensive cultivation with scattered pasture and woodlands
Transition Zone					
5	Cultivation		Cultivated, Marsh, Open	Forest, Water, Extractive	Cultivation with pasture on rolling or rough land
6	Cultivation		Forest, Cultivated, Marsh, Open	Water, Urban, Extractive	Cultivation with pasture and woodland on poorly-drained or rough areas
7	Cultivation	Water, Marsh	Forest, Cultivation	Open	Cultivation with water, forest, and pasture
8	Cultivation	Water	Forest, Cultivation, Marsh, Open	Urban	Cultivation with forest, pasture, and water; sparsely developed lakeshore
9	Cultivation	Water	Forest, Cultivation, Marsh, Urban, Open	Extractive	Cultivation with water, forest, and pasture; much developed lakeshore
Forest Zone					
10	Forest	Forest	Marsh	Cultivation, Water, Urban, Open	Forest
11	Forest	Forest, Water	Marsh	Open	Forest with lakeshore undeveloped

TABLE 1 (continued)

--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

Land Use Combination	Land Use Dominant on Greatest Acreage	Land Uses Present in High Percentage Compared with State Total	Other Land Uses Present in Moderate Percentages Compared with State Totals	Other Uses Present on Small But Significant Acreage	Landscape Description
Forest Zone (contd.)					
12	Forest	Forest, Water	Marsh	Urban, Open	Forest with sparsely developed lakeshore
13	Forest	Forest, Water	Urban	Marsh, Extractive, Open	Forest with much developed lakeshore
14	Forest	Forest, Extractive	Water, Urban	Open, Cultivation	Forest with extensive mining
15	Forest	Marsh	Forest, Open	Cultivation	Marsh and forest
Urban Zone					
16	Urban	Urban	Open	Cultivation, Forest	Urban Development with Scattered Farmlands and Woods
17	Urban	Urban	Water	Open, Forest	Urban Development with Some Lakeshore
18	Urban	Urban		Forest, Open, Cultivation	Dense Urban Development

--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

TABLE 2 Distribution of Land Use Classes in Each Land Use Combination (in acres)

Land Use Combination	Major Land Use Classes							
	Cultivation	Forest	Open	Marsh	Water	Urban	Extractive	Total
Cultivated Zone								
1) Intensive cultivation on prairie plains	5,084,480	10,480	205,440	6,800	1,360	22,000	2,080	5,332,640
2) Intensive cultivation with scattered woodlands	2,119,720	139,520	80,920	3,800	640	17,080	1,200	2,362,880
3) Intensive cultivation with scattered pasture	6,070,720	91,320	646,160	66,640	100,040	35,720	3,200	7,013,800
4) Intensive cultivation with scattered pasture and woodlands	842,080	43,760	136,160	1,640	160	5,400	1,120	1,030,320
Transition Zone								
5) Cultivation with pasture on rolling or rough land	2,056,280	104,880	764,480	59,960	42,280	49,400	2,600	3,079,880
6) Cultivation with pasture and woodland on poorly-drained or rough areas	3,579,000	1,469,280	1,772,600	185,640	80,040	165,200	4,840	7,256,600
7) Cultivation with water, forest, and pasture	1,485,240	595,960	326,960	425,280	511,760	12,720	920	3,328,840
8) Cultivation with forest, pasture, and water; sparsely developed lakeshore	817,920	212,160	240,000	48,440	223,360	38,320	200	1,580,400
9) Cultivation with water, forest, and pasture; much developed lakeshore	555,840	301,400	283,600	54,080	335,560	169,880	1,400	1,701,760
Forest Zone								
10) Forest	670,240	7,270,640	944,240	423,160	142,360	78,440	3,720	9,532,800
11) Forest with lakeshore undeveloped	188,840	5,972,040	238,840	325,200	1,415,880	52,880	1,840	8,195,520
12) Forest with sparsely developed lakeshore	50,720	736,960	72,840	29,960	185,520	27,000	80	1,103,080
13) Forest with much developed lakeshore	57,720	746,200	89,320	19,520	203,920	82,600	880	1,200,160
14) Forest with extensive mining	16,440	438,560	47,160	4,160	21,560	28,000	62,280	618,160
15) March and forest	94,000	210,360	105,800	205,720	4,640	1,360	80	621,960
Urban Zone								
16) Urban development with scattered farmlands and woods	34,240	15,240	32,280	3,840	3,560	188,360	640	278,160
17) Urban development with some lakeshore	7,760	10,440	10,800	3,000	15,000	109,080	80	156,160
18) Dense urban development	8,400	2,200	3,600	200	2,040	135,040	0	151,480
STATE TOTALS	23,739,640	18,371,400	6,001,200	1,867,040	3,289,680	1,218,480	87,160	54,544,600

--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

TABLE 3 Distribution of Land Use Classes in Each Land Use Combination (in percent)

Landscape Description	Major Land Use Classes							
	Cultivation	Forest	Open	Marsh	Water	Urban	Extractive	Total
Cultivated Zone								
1) Intensive cultivation on prairie plains	95.3	.2	3.9	.1	*	.4	*	100.0
2) Intensive cultivation with scattered woodlands	89.7	5.9	3.4	.2	*	.7	*	100.0
3) Intensive cultivation with scattered pasture	86.5	1.3	9.2	1.0	1.4	.5	*	100.0
4) Intensive cultivation with scattered pasture and woodlands	81.7	4.2	13.2	.2	*	.5	.1	100.0
Transition Zone								
5) Cultivation with pasture on rolling or rough land	66.8	3.4	24.8	1.9	1.4	1.6	*	100.0
6) Cultivation with pasture and woodland on poorly-drained or rough areas	49.3	20.2	24.4	2.6	1.1	2.3	*	100.0
7) Cultivation with water, forest, and pasture	43.1	16.5	9.7	12.2	14.7	3.7	*	100.0
8) Cultivation with forest, pasture, and water; sparsely developed lakeshore	51.7	13.4	15.2	3.1	14.1	2.4	*	100.0
9) Cultivation with water, forest, and pasture; much developed lakeshore	32.6	17.7	16.7	3.2	19.7	10.0	*	100.0
Forest Zone								
10) Forest	7.0	76.3	9.9	4.4	1.5	.8	*	100.0
11) Forest with lakeshore undeveloped	2.3	72.8	2.9	4.0	17.3	.6	*	100.0
12) Forest with sparsely developed lakeshore	4.6	66.8	6.6	2.7	16.8	2.4	*	100.0
13) Forest with much developed lakeshore	4.8	62.2	7.4	1.6	17.0	6.9	*	100.0
14) Forest with extensive mining	2.7	70.9	7.6	.7	3.5	4.5	10.1	100.0
15) Marsh and forest	15.1	33.8	17.0	33.1	.7	.2	*	100.0
Urban Zone								
16) Urban development with scattered farmlands and woods	12.3	5.5	11.6	1.4	1.3	67.7	.2	100.0
17) Urban development with some lakeshore	5.0	6.7	6.9	1.9	9.6	69.8	*	100.0
18) Dense urban development	5.5	1.5	2.4	.1	1.3	89.2	0	100.0
STATE-WIDE PERCENTAGE	43.6	33.8	10.9	3.4	6.0	2.2	.1	100.0

* = less than .1%

--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

TABLE 4 Distribution of Public Ownership by Land Use Combination

Landscape Description	Land Owned By: Federal Government Acres	% of Total	State Government Acres	% of Total	County Government t Acres	% of Total	Total Public Ownership in Each Land Use Combination	% of Total
Cultivated Zone								
1) Intensive cultivation on prairie plains	3,640	*	10,560	.3	0	0	14,200	.1
2) Intensive cultivation with scattered woodlands	2,760	*	5,480	.1	0	0	8,240	*
3) Intensive cultivation with scattered pasture	66,800	1.6	61,520	1.4	80	*	128,400	1.1
4) Intensive cultivation with scattered pasture and woodlands	200	*	7,400	.2	0	0	7,600	*
Transition Zone								
5) Cultivation with pasture on rolling or rough land	48,160	1.1	45,480	1.1	3,920	.1	97,560	.9
6) Cultivation with pasture and woodland on poorly-drained or rough areas	55,480	1.3	171,000	4.0	16,720	.6	243,200	2.1
7) Cultivation with water, forest, and pasture	470,080	10.9	468,720	11.0	25,240	.9	964,040	8.4
8) Cultivation with forest, pasture, and water; sparsely developed lakeshore	35,600	.8	25,160	.6	5,680	.2	66,440	.6
9) Cultivation with water, forest, and pasture; much developed lakeshore	36,720	.9	32,080	.8	4,960	.2	73,760	.7
Forest Zone								
10) Forest	617,760	14.3	1,281,960	30.1	1,590,000	55.8	3,489,720	30.6
11) Forest with lakeshore undeveloped	2,624,080	60.8	1,613,200	37.7	825,120	28.9	5,062,400	44.4
12) Forest with sparsely developed lakeshore	204,320	4.7	103,040	2.4	130,880	4.6	438,240	3.8
13) Forest with much developed lakeshore	75,640	1.8	70,360	1.7	176,760	6.2	322,760	2.8
14) Forest with extensive mining	42,120	1.0	44,360	1.0	56,960	2.0	143,440	1.3
15) March and forest	27,960	.7	318,240	7.5	10,720	.4	356,920	3.1
Urban Zone								
16) Urban development with scattered farmlands and woods	280	*	3,440	*	0	0	3,720	*
17) Urban development with some lakeshore	2,120	*	2,360	*	0	0	4,480	*
18) Dense urban development	160	*	1,280	*	0	0	1,440	*
TOTALS	4,313,880	100.0	4,265,640	100.0	2,847,040	100.0	11,426,560	100.0

8 = less than .1% t = From: Land Use Classification Program, Department of Natural Resources, 1969

--From Minnesota Land Management Information System, University of Minnesota Center for Urban and Regional Affairs (CURA) and Minnesota State Planning Agency.

TABLE 5 Public Ownership as a Percentage of Total Area In Each Land Use Combination

Landscape Description	Total Acreage	Acres of Public Ownership	Public Ownership As % of Total
Cultivated Zone			
1) Intensive cultivation on prairie plains	5,332,640	14,200	.3
2) Intensive cultivation with scattered woodlands	2,362,880	8,240	.4
3) Intensive cultivation with scattered pasture	7,013,800	128,400	1.8
4) Intensive cultivation with scattered pasture and woodlands	1,030,320	7,600	.7
Transition Zone			
5) Cultivation with pasture on roll	3,079,880	97,560	3.2
6) Cultivation with pasture and woodland on poorly-drained or rough areas	7,256,600	243,200	3.4
7) Cultivation with water, forest, and pasture	3,328,840	964,040	29.0
8) Cultivation with forest, pasture, and water; sparsely developed lakeshore	1,580,400	66,440	4.2
9) Cultivation with water, forest, and pasture; much developed lakeshore	1,701,760	73,760	4.3
Forest Zone			
10) Forest	9,532,800	3,489,720	36.6
11) Forest with lakeshore undeveloped	8,195,520	5,062,400	61.8
12) Forest with sparsely developed lakeshore	1,103,080	438,240	39.7
13) Forest with much developed lakeshore	1,200.160	322,760	26.9
14) Forest with extensive mining	618,160	143,440	23.2
15) Marsh and forest	621,960	356,920	57.4
Urban Zone			
16) Urban development with scattered farmlands and woods	278,160	3,720	1.3
17) Urban development with some lakeshore	156,160	4,480	2.9
18) Dense urban development	151,480	1,440	1.0
TOTALS	54,544,600	11,426,560	21.0